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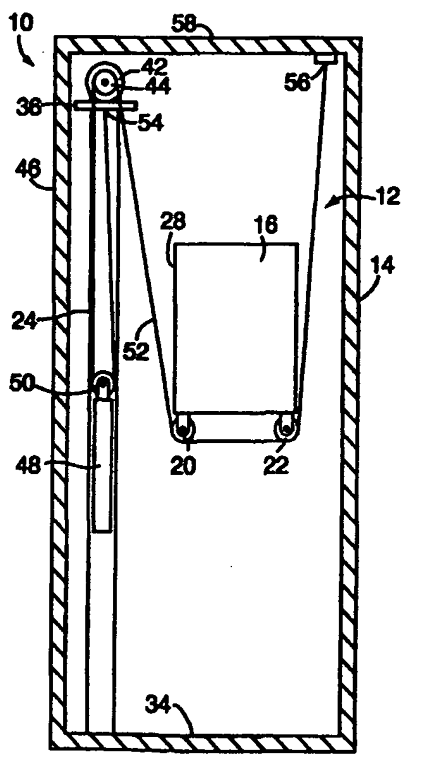
(54) Title: ELEVATOR SYSTEM HAVING DRIVE MOTOR LOCATED BETWEEN ELEVATOR CAR AND HOISTWAY SIDEWALL

(57) Abstract

An elevator system includes a hoistway defined by a surrounding structure. An elevator car and counterweight are located in the hoistway, and a drive motor is located between the elevator car and a sidewall of the hoistway. The drive motor drivingly couples and suspends the elevator car and counterweight via at least one flat rope or belt.



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ELEVATOR SYSTEM HAVING DRIVE MOTOR LOCATED BETWEEN ELEVATOR CAR AND HOISTWAY SIDEWALL

FIELD OF THE INVENTION

The present invention relates generally to an elevator system, and more particularly to an elevator system including a drive motor provided between an elevator car and a hoistway sidewall.

BACKGROUND OF THE INVENTION

Considerable expense is involved in the construction of a machine room for an elevator. The expense includes the cost of constructing the machine room, the structure required to support the weight of the machine room and elevator equipment, and the cost of shading adjacent properties from sunlight (e.g., sunshine laws in Japan and elsewhere).

It is an object of the present invention to provide an elevator system without a machine room which avoids the above-mentioned drawbacks associated with prior elevator systems.

It is a further object of the present invention to employ flat rope technology to reduce the size of the drive motor and sheaves so that either conventional or flat drive motors may be placed within the space between the elevator car and sidewall of the hoistway.

SUMMARY OF THE INVENTION

An elevator system includes a hoistway defined by a surrounding structure. An elevator car and counterweight are located in the hoistway, and a drive motor is located between the elevator car and a sidewall of the hoistway. The drive motor drivingly couples and suspends the elevator car and counterweight via at least one flat rope or belt.

An advantage of the present invention is that the elevator system significantly reduces the space and construction costs associated with an elevator system having a machine room.

A second advantage of the present invention is the provision of several alternative drive motor locations.

A third advantage of the present invention is that flat rope technology reduces the size of the drive motor and sheaves, and thereby reduces the space between the elevator car and sidewall of the hoistway required for accommodating the motor and sheaves.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic, top plan view of an elevator system embodying the present invention.

FIG. 2 is a schematic, side elevational view of the elevator system of FIG. 1 showing an underslung roping configuration.

FIG. 3 is a schematic, side elevational view of a second embodiment of the present invention illustrating an elevator system employing a 1:1 roping configuration.

FIG. 4 is a schematic, side elevational view of another embodiment of the present invention.

FIG. 5 is a schematic, top plan view of an elevator system in accordance with a further embodiment of the present invention showing the drive motor in the hoistway pit.

FIG. 6 is a schematic, partial, side elevational view of the elevator system of FIG. 5.

FIG. 7 is a sectional, side view of a traction sheave and a plurality of flat ropes, each having a plurality of cords.

FIG. 8 is a sectional view of one of the flat ropes.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIGS. 1-2, an elevator system embodying the present invention is generally designated by the reference number 10. The elevator system includes a hoistway 12 defined by a surrounding structure 14. An elevator car 16 is disposed in the hoistway 12 for upward and downward movement therealong. First and second elevator sheaves 20, 22 are coupled to an underside of the elevator car 16 at opposite sides relative to each other. The elevator system 10 includes first and second support columns 24, 26 disposed at one side 28 of the elevator car 16, and generally at opposite sides 30, 32 of the hoistway 12 relative to each other. Each of the first

and second support columns 24, 26 extends vertically from a bottom portion or floor 34 of the hoistway 12 to an upper portion of the hoistway. A support member 36 (shown by the dashed lines in FIG. 1) is mounted on and extends generally horizontally between the first and second support columns 24, 26 at a top portion of the hoistway 12.

A drive motor 42, including a drive sheave 44 drivingly coupled to the drive motor, is supported on the support member 36 and is aligned within a vertically extending space along the hoistway 12 between the elevator car 16 and a sidewall 46 of the hoistway.

The elevator system 10 further includes a counterweight 48 having a counterweight sheave 50 coupled to a top portion of the counterweight. The counterweight 48 is situated below and preferably aligned with the drive motor 42 in the vertically-extending space along the hoistway 12 between the elevator car 16 and the sidewall 46. The counterweight 48 is coupled to the elevator car 16 via a flat rope or belt for balancing the elevator car during its vertical movement along the hoistway 12.

The employment of flat ropes or belts permits smaller drive motors and sheaves to drive and suspend elevator car and counterweight loads relative to drive motors and sheaves using conventional round ropes. The diameter of drive sheaves used in elevators with conventional round ropes is limited to 40 times the diameter of the ropes, or larger, due to fatigue of the ropes as they repeatedly conform to the diameter of the sheave and straighten out. Flat ropes or belts have an aspect ratio greater than one, where aspect ratio is defined as the ratio of rope or belt width w to thickness t (Aspect Ratio = w/t). Therefore, flat ropes or belts are inherently thin relative to conventional round ropes. Being thin, there is less bending stress in the fibers when the belt is wrapped around a given diameter sheave. This allows the use of smaller diameter traction sheaves. Torque is proportional to the diameter of the traction sheave. Therefore, the use of a smaller diameter traction sheave reduces motor torque. Motor size (rotor volume) is roughly proportional to torque; therefore, although the mechanical output power remains the same regardless of sheave size, flat ropes or belts allow the use of a smaller drive motor operating at a higher speed relative to systems using

conventional round ropes. Consequently, smaller conventional and flat drive motors may be accommodated in the hoistway between the elevator car and a sidewall of the hoistway which significantly reduces the size and construction cost of the hoistway.

In summary, reducing the machine size (i.e., drive motor and sheaves) has a number of advantages. First, the smaller machine reduces the hoistway space requirement when the machine is located above the elevator car and sidewall of the hoistway. Second, a small machine utilizes less material, and will be less costly to produce relative to a larger machine. Third, the light weight of a small machine reduces the time for handling the machine and the need for equipment to lift the machine into place so as to significantly reduce installation cost. Fourth, low torque and high speed allow the elimination of gears, which are costly. Further, gears can cause vibrations and noise, and require maintenance of lubrication. However, geared machines may be employed if desired.

Flat ropes or belts also distribute the elevator and counterweight loads over a greater surface area on the sheaves relative to round ropes for reduced specific pressure on the ropes, thus increasing its operating life. Furthermore, the flat ropes or belts may be made from a high traction material such as urethane or rubber jacket with fiber or steel reinforcement.

The flat rope 52 has first and second ends 54, 56 each coupled within a top portion of the hoistway 12. Preferably, the first end 54 of the flat rope 52 is coupled to the support member 36 and the second end 56 of the flat rope is coupled to a ceiling 58 of the hoistway 12. As shown in FIG. 2, the flat rope 52 extends downwardly from its first end 54 at the support member 36, loops generally 180° about the counterweight sheave 50, extends upwardly and loops generally 180° about the drive sheave 44, extends generally downwardly and underslings the elevator car 16 via the first and second elevator sheaves 20, 22, and extends generally upwardly and terminates at its second end 56 at the ceiling 58 of the hoistway 12.

First and second guide members 60, 62 for guiding the elevator car 16 and the counterweight 48 are respectively disposed along the length of the first and second support columns 24, 26. The

guide members 60, 62 may be formed integrally with the support columns 24, 26 or may be separate from and disposed about a perimeter of the support columns. As shown in FIG. 1, the first and second guide members 60, 62 respectively define first and second elevator guide surfaces 64, 66. The first and second elevator guide surfaces 64, 66 respectively extend vertically along the first and second support columns 24, 26 at least over a length of the support columns corresponding to the path of elevator car travel. Opposing surfaces 68, 70 of the elevator car 16 are shaped to be movably engagable with respective first and second elevator guide surfaces 64, 66 as the elevator car moves vertically along the first and second support columns 24, 26. The first and second guide members 60, 62 also respectively define first and second counterweight guide surfaces 72, 74. The first and second counterweight guide surfaces 72, 74 respectively extend vertically along the first and second support columns 24, 26 at least over a length of the support columns corresponding to the path of counterweight travel. Additional opposing surfaces 76, 78 of the counterweight 48 are shaped to be movably engagable with respective first and second counterweight guide surfaces 72, 74 as the counterweight moves vertically along the support columns. For clarity in showing the roping configuration in FIG. 2, the elevator car 16 is shown as being spaced from the first and second support columns 24, 26.

In operation, the drive motor 42 is signaled by a controller (not shown) to rotate the drive sheave 44 in a counterclockwise direction to move the elevator car 16 upwardly along the hoistway 12. The counterclockwise rotating drive sheave 44 pulls a portion of the flat rope 52 between the drive sheave 44 and the elevator sheaves 20, 22 upwardly, and in turn, causes the elevator sheaves to roll along the flat rope toward its second end 56 to thereby move the elevator 16 upwardly along the hoistway 12. As the drive sheave 44 rotates in a counterclockwise direction, a portion of the flat rope 52 looping over the drive sheave 44 and extending downwardly toward the counterweight sheave 50 increases in length causing the counterweight sheave to rotate counterclockwise, whereby the counterweight 48 is lowered along the hoistway 12.

The drive motor 42 is also signaled by a controller to rotate the drive sheave 44 in a clockwise direction to move the elevator car 16 downwardly along the hoistway 12. The clockwise rotating drive sheave 44 pulls a portion of the flat rope 52 looping about the drive sheave 44 and extending downwardly toward the counterweight sheave 50 which causes the counterweight sheave to rotate in a clockwise direction, to thereby move the counterweight 48 upwardly along the hoistway 12. The clockwise rotating drive sheave 44 also lengthens a portion of the flat rope 52 between the drive sheave and the second end 56 of the flat rope 52 which causes the elevator sheaves 20, 22 to roll along the flat rope away from its second end to thereby move the elevator car 16 downwardly along the hoistway 12.

As shown in FIGS. 1-2, the provision of the drive motor within the space along the hoistway between the elevator car and a sidewall of the hoistway minimizes internal building height requirements because no machinery occupies the overhead projection of the elevator car or within the hoistway pit. The provision of the machinery to the side of the elevator car also reduces the overhead dimension of the hoistway in that space is only required for rope elongation, buffer stroke and jump allowance for the counterweight.

Turning now to FIG. 3, an elevator system in accordance with a second embodiment of the present invention is generally designated by the reference number 100. Like elements with the elevator system 10 of FIGS. 1 and 2 are labeled with like reference numbers. The elevator system 100 is similar to the elevator system 10 except that the elevator system 100 employs a 1:1 roping configuration which does not employ a counterweight sheave or elevator sheaves. The embodiment of FIG. 3 will be explained with respect to its aspects which are different from previous embodiments.

A first end 102 of the flat rope 52 is coupled to a top portion of the counterweight 48, and a second end 104 of the flat rope is coupled to a lower portion of the elevator car 16. The flat rope 52 extends generally upwardly from its first end 102 at a top portion of the counterweight 48, loops generally 180° about the drive sheave 44, and extends generally downwardly and is coupled to a lower portion of the elevator car 16 at 106. For clarity in showing the roping

configuration, the elevator car 16 is shown as being spaced from the first and second support columns 24, 26.

In operation, the drive motor 42 is signaled by a controller (not shown) to rotate the drive sheave 44 in a counterclockwise direction to move the elevator car 16 upwardly along the hoistway 12. The counterclockwise rotating drive sheave 44 pulls a portion of the flat rope 52 between the drive sheave and the elevator car 16 upwardly, and in turn, causes the elevator car to move upwardly along the hoistway 12 via the guide members 60, 62. As the drive sheave 44 rotates in a counterclockwise direction, a portion of the flat rope 52 extending between the drive sheave 44 and the counterweight 48 increases in length, whereby the counterweight is lowered along the hoistway 12.

The drive motor is also signaled by a controller to rotate the drive sheave 44 in a clockwise direction to move the elevator car 16 downwardly along the hoistway 12 via the guide members 60, 62. The clockwise rotating drive sheave 44 pulls upwardly a portion of the flat rope 52 extending between the drive sheave and the counterweight 48 which causes the counterweight to move upwardly along the hoistway 12. The clockwise rotating drive sheave 44 also lengthens a portion of the flat rope 52 between the drive sheave and the elevator car 16 which causes the elevator car to move downwardly along the hoistway 12.

Turning now to FIG. 4, an elevator system in accordance with a third embodiment of the present invention is generally designated by the reference number 200. Like elements with the previous embodiments are labeled with like reference numbers. The embodiment of FIG. 4 will be explained with respect to its aspects which are different from the previous embodiments.

A drive motor 202, and drive sheave 204 are coupled within a top portion of the hoistway 12, such as a sidewall 206 (as shown in FIG. 4) or the ceiling 208 of the hoistway. The drive motor 202 may be, for example, geared or belt-reduced to reduce the required motor torque, and is aligned within a vertically extending space of the hoistway 12 that is between an elevator car 16 disposed within the hoistway and the sidewall 206 of the hoistway. The elevator car includes first and second elevator sheaves 20, 22 coupled to an

underside of the elevator car and at opposite sides of the car relative to each other. A counterweight 48 and counterweight sheave 50 coupled to its top portion are disposed below the drive motor 202, and are preferably aligned with the drive motor in the space along the hoistway 12 between the elevator car 16 and the sidewall 206. A flat rope or belt 210 has first and second ends 212, 214 coupled to a top portion of the hoistway 12. As shown in FIG. 4, the first and second ends 212, 214 are coupled to the ceiling 208 of the hoistway 12 at generally opposite sides relative to each other. The flat rope 210 extends generally downwardly from its first end 212, loops generally 180° about the counterweight sheave 50, extends generally upwardly and loops generally 180° about the drive sheave 204, extends generally downwardly and underslings the elevator car 16 via the elevator sheaves 20, 22, and extends generally upwardly and terminates at its second end 214 at the ceiling 208 of the hoistway 12. The operation of the elevator system 200 with respect to the employment of the roping configuration to move the elevator car 16 and the counterweight 48 is similar to that of the elevator system 10 of FIGS. 1 and 2, and therefore will not be further explained.

With reference to FIGS. 5 and 6, an elevator system in accordance with a further embodiment of the present invention is generally designated by the reference number 300. Like elements from previous embodiments are labeled with like reference numbers. The embodiment of FIGS. 5 and 6 will be explained with respect to its aspects which are different from the previous embodiments.

The elevator system 300 includes a first support member 302 extending generally horizontally between and coupled to opposite sides 304, 306 of the hoistway 12 at a top portion of the hoistway and is over a vertically extending space along the hoistway between an elevator car 16 and a sidewall 308 of the hoistway. A second support member 310 likewise extends generally horizontally between and is coupled to the opposite sides 304, 306 of the hoistway 12 at a top portion of the hoistway, preferably at the same level as the first support member 302. The second support member 310 is aligned over the vertically extending space along the hoistway 12 between the elevator car 16 and the sidewall 308, and is interposed between the

first support member 302 and the elevator car. First and second deflector sheaves 312, 314 are respectively coupled to the first and second support members 302, 310.

A counterweight 316 having a counterweight sheave 318 coupled to its top portion is preferably disposed below the first and second support members 302, 310 within the vertically extending space along the hoistway 12 between the elevator car 16 and the sidewall 308 for easy and safe access thereto by maintenance workers. The elevator car 16 and the counterweight 316 are moved upwardly and downwardly along the hoistway 12, in part, by means of a drive motor 320, such as a direct drive brushless motor, and associated drive sheave 322 situated at a lower portion of the hoistway within the vertically extending space along the hoistway between the elevator car 16 and the sidewall 308. As shown in FIG. 6, the drive motor 320 and the drive sheave 322 are mounted to a floor 324 within a hoistway pit 326. A flat rope or belt 328 is drivingly engaged with the drive sheave 322 to move the elevator car 16 and the counterweight 316 vertically along the hoistway 12. The flat rope 328 has first and second ends 330, 332 coupled within a top portion of the hoistway 12. As shown in FIG. 6, the first end 330 of the flat rope 328 is coupled to the second support member 310 and the second end 332 is coupled to a ceiling 334 of the hoistway 12 generally at an opposite side of the elevator car 16 relative to the first end 330. The flat rope 328 extends generally downwardly from its first end 330 at the second support member 310, loops generally 180° about the counterweight sheave 318, extends generally upwardly and loops generally 180° about the first deflector sheave 312, extends generally downwardly and loops generally 180° about the drive sheave 322, extends generally upwardly and loops generally 180° about the second deflector sheave 314, extends generally downwardly and underslings the elevator car 16 via the first and second elevator sheaves 20, 22, and extends generally upwardly and terminates at its second end 332 at the ceiling 334 of the hoistway.

In operation, the drive motor 320 is signaled by a controller (not shown) to rotate the drive sheave 322 in a clockwise direction which pulls downwardly on a portion of the flat rope 328 between the drive sheave 322 and the second support member 310.

This downwardly moving portion of the flat rope 328 in turn causes the second deflector sheave 314 to rotate so as to shorten the length of a portion of the flat rope between the second deflector sheave 314 and the second end 332 of the flat rope. The elevator sheaves 20, 22 are caused by this shortening portion of the flat rope 328 to roll therealong toward its second end 332, thereby moving the elevator car 16 upwardly along the hoistway 12. The clockwise rotating drive sheave 322 also moves upwardly a portion of the flat rope 328 between the drive sheave 322 and the first deflector sheave 302 causing the first deflector sheave to rotate so as to move the counterweight 316 downwardly along the hoistway 12.

The drive motor 320 is also signaled by a controller to rotate the drive sheave 322 in a counterclockwise direction which moves upwardly a portion of the flat rope 328 between the drive sheave and the second support member 310. This upwardly moving portion of the flat rope 328 in turn causes the second deflector sheave 310 to rotate so as to increase the length of a portion of the flat rope between the second deflector sheave and the second end 332 of the flat rope. The elevator sheaves 20, 22 are caused by this lengthening portion of the flat rope 328 to roll therealong away from its second end 332, thereby moving the elevator car 16 downwardly along the hoistway 12. The counterclockwise rotating drive sheave 322 also moves downwardly a portion of the flat rope 328 between the drive sheave and the first deflector sheave 302 causing the first deflector sheave to rotate so as to move the counterweight 316 upwardly along the hoistway 12.

A principal feature of the present invention is the flatness of the ropes used in the above described elevator system. The increase in aspect ratio results in a rope that has an engagement surface, defined by the width dimension "w", that is optimized to distribute the rope pressure. Therefore, the maximum rope pressure is minimized within the rope. In addition, by increasing the aspect ratio relative to a round rope, which has an aspect ratio equal to one, the thickness "t1" of the flat rope (see FIG. 8) may be reduced while maintaining a constant cross-sectional area of the portions of the rope supporting the tension load in the rope.

As shown in FIG. 7 and 8, the flat ropes 722 include a plurality of individual load carrying cords 726 encased within a common layer of coating 728. The coating layer 728 separates the individual cords 726 and defines an engagement surface 730 for engaging the traction sheave 724. The load carrying cords 726 may be formed from a high-strength, lightweight non-metallic material, such as aramid fibers, or may be formed from a metallic material, such as thin, high-carbon steel fibers. It is desirable to maintain the thickness "d" of the cords 726 as small as possible in order to maximize the flexibility and minimize the stress in the cords 726. In addition, for cords formed from steel fibers, the fiber diameters should be less than .25 millimeters in diameter and preferably in the range of about .10 millimeters to .20 millimeters in diameter. Steel fibers having such diameter improve the flexibility of the cords and the rope. By incorporating cords having the weight, strength, durability and, in particular, the flexibility characteristics of such materials into the flat ropes, the traction sheave diameter "D" may be reduced while maintaining the maximum rope pressure within acceptable limits.

The engagement surface 730 is in contact with a corresponding surface 750 of the traction sheave 724. The coating layer 728 is formed from a polyurethane material, preferably a thermoplastic urethane, that is extruded onto and through the plurality of cords 726 in such a manner that each of the individual cords 726 is restrained against longitudinal movement relative to the other cords 726. Other materials may also be used for the coating layer if they are sufficient to meet the required functions of the coating layer: traction, wear, transmission of traction loads to the cords and resistance to environmental factors. It should be understood that although other materials may be used for the coating layer, if they do not meet or exceed the mechanical properties of a thermoplastic urethane, then the benefits resulting from the use of flat ropes may be reduced. With the thermoplastic urethane mechanical properties the traction sheave 724 diameter is reducible to 100 millimeters or less.

As a result of the configuration of the flat rope 722, the rope pressure may be distributed more uniformly throughout the rope 722. Because of the incorporation of a plurality of small cords 726 into

the flat rope elastomer coating layer 728, the pressure on each cord 726 is significantly diminished over prior art ropes. Cord pressure is decreased at least as $n^{-1/2}$, with n being the number of parallel cords in the flat rope, for a given load and wire cross section. Therefore, the maximum rope pressure in the flat rope is significantly reduced as compared to a conventionally roped elevator having a similar load carrying capacity. Furthermore, the effective rope diameter 'd' (measured in the bending direction) is reduced for the equivalent load bearing capacity and smaller values for the sheave diameter 'D' may be attained without a reduction in the D/d ratio. In addition, minimizing the diameter D of the sheave permits the use of less costly, more compact, high speed motors as the drive machine.

A traction sheave 724 having a traction surface 750 configured to receive the flat rope 722 is also shown in FIG. 7. The engagement surface 750 is complementarily shaped to provide traction and to guide the engagement between the flat ropes 722 and the sheave 724. The traction sheave 724 includes a pair of rims 744 disposed on opposite sides of the sheave 724 and one or more dividers 745 disposed between adjacent flat ropes. The traction sheave 724 also includes liners 742 received within the spaces between the rims 744 and dividers 745. The liners 742 define the engagement surface 750 such that there are lateral gaps 754 between the sides of the flat ropes 722 and the liners 742. The pair of rims 744 and dividers, in conjunction with the liners, perform the function of guiding the flat ropes 722 to prevent gross alignment problems in the event of slack rope conditions, etc. Although shown as including liners, it should be noted that a traction sheave without liners may be used.

Although this invention has been shown and described with respect to several embodiments thereof, it should be understood by those skilled in the art that the foregoing and various other changes, omissions, and additions in the form and detail thereof may be made therein without departing from the spirit and scope of the invention. For example, other roping configurations may be employed where the drive motor is disposed to the side of the hoistway between the elevator car and a sidewall of the hoistway. Further, the drive motor may also be disposed in the overhead space of the hoistway between

the elevator car and a sidewall. Accordingly, the invention has been described and shown in several embodiments by way of illustration rather than limitation.

WHAT IS CLAIMED IS:

1. An elevator system comprising:

a hoistway defined by a surrounding structure;

an elevator car and counterweight located in the hoistway; and

a drive motor located between the elevator car and a sidewall of the hoistway, the drive motor drivingly coupling and suspending the elevator car and counterweight via at least one flat rope.

2. An elevator system as defined in claim 1, further including first and second support columns located on opposite sides of a hoistway relative to each other, each of the support columns extending vertically from a bottom portion to a top portion of the hoistway between the elevator car and said sidewall of the hoistway; and

a support member mounted on and extending generally horizontally between the first and second support columns at a top portion of the hoistway, and wherein the drive motor is supported on the support member.

3. An elevator system as defined in claim 2, wherein the counterweight is located underneath the support member between the elevator car and said sidewall of the hoistway, and the drive motor includes a drive sheave drivingly coupling the elevator car and the counterweight via the flat rope.

4. An elevator system as defined in claim 3, further including a counterweight sheave coupled to a top portion of the counterweight, and at least one elevator sheave coupled to an underside of the elevator car, the flat rope having first and second ends fixedly coupled at a top portion of the hoistway, the flat rope extending downwardly from the first end, looping about the counterweight sheave, extending upwardly and looping about the drive sheave, extending downwardly and underslinging the elevator car via the at least one elevator sheave, and extending upwardly and terminating at the second end.

5. An elevator system as defined in claim 4, wherein the at least one elevator sheave includes first and second elevator sheaves located at an underside of the elevator car and at opposite sides relative to each other.

6. An elevator system as defined in claim 4, wherein the first end of the flat rope is coupled to the support member.

7. An elevator system as defined in claim 2, wherein the drive motor includes a drive sheave drivingly coupling the elevator car and the counterweight via the flat rope, the counterweight is located underneath the support member between the elevator car and the sidewall of the hoistway, the flat rope has a first end coupled to a top portion of the counterweight and a second end coupled to the elevator car, the flat rope extending upwardly from its first end at the counterweight, looping about the drive sheave, and extending downwardly and terminating at its second end at the elevator car to form a 1:1 roping configuration.

8. An elevator system as defined in claim 2, wherein the first and second support columns respectively include first and second guide members, each of the guide members defining an elevator guide surface extending vertically therealong at least over a length of the support columns corresponding to the path of elevator car travel, and the elevator car defining opposing surfaces shaped to be movably engagable with the elevator guide surfaces as the elevator car moves vertically along the support columns.

9. An elevator system as defined in claim 8, wherein each of the first and second guide members further defines a counterweight guide surface extending vertically therealong at least over a length of the support columns corresponding to the path of counterweight travel, and the counterweight defines additional opposing surfaces shaped to be movably engagable with the counterweight guide surfaces as the counterweight moves vertically along the support columns.

10. An elevator system as defined in claim 1, wherein the drive motor is fixedly coupled to one of a ceiling of the hoistway and a sidewall at a top portion of the hoistway.

11. An elevator system as defined in claim 10, wherein the drive motor is coupled to a sidewall of the hoistway.

12. An elevator system as defined in claim 10, wherein the flat rope has first and second ends each coupled to one of a sidewall and ceiling of the hoistway.

13. An elevator system as defined in claim 10, wherein the flat rope has first and second ends each coupled to a ceiling of the hoistway.

14. An elevator system as defined in claim 12, wherein the counterweight is located underneath the support member between the elevator car and the sidewall of the hoistway, and including a counterweight sheave coupled to a top portion of the counterweight, at least one elevator sheave coupled to an underside of the elevator car, a drive sheave drivingly coupled to the drive motor, and the flat rope extends downwardly from its first end, loops about the counterweight sheave, extends upwardly and loops about the drive sheave, extends downwardly and underslings the elevator car via the at least one elevator sheave, and extends upwardly and terminates at its second end.

15. An elevator system as defined in claim 1, further including a first support member extending generally horizontally between and disposed at opposite sides of the hoistway at a top portion of the hoistway between the elevator car and the sidewall of the hoistway, a second support member extending generally horizontally between and disposed at opposite sides of the hoistway at a top portion of the hoistway between the first support member and the elevator car, first and second deflector sheaves respectively coupled to the first and second support members, a counterweight sheave coupled to a top portion of the counterweight, at least one elevator sheave coupled to an underside of the elevator car, the drive motor including a drive sheave, and wherein the drive motor and the drive sheave are disposed at a lower portion of the hoistway between the elevator car and a sidewall of the hoistway.

16. An elevator system as defined in claim 15, wherein the flat rope has a first end coupled to the second support member and a second end coupled to one of a ceiling and sidewall of the hoistway at a top portion of the hoistway, the flat rope extending downwardly from its first end, looping about the counterweight sheave, extending upwardly and looping about the first deflector sheave, extending downwardly and looping about the drive sheave, extending upwardly and looping about the second deflector sheave, extending downwardly and underslinging the elevator car via the at least one elevator sheave, and extending upwardly and terminating at its second end.

17. An elevator system as defined in claim 15, wherein the flat rope is coupled at its second end to a ceiling of the hoistway.

18. An elevator system as defined in claim 15, wherein the at least one elevator sheave includes first and second elevator sheaves located at an underside of the elevator car and at opposite sides relative to each other.

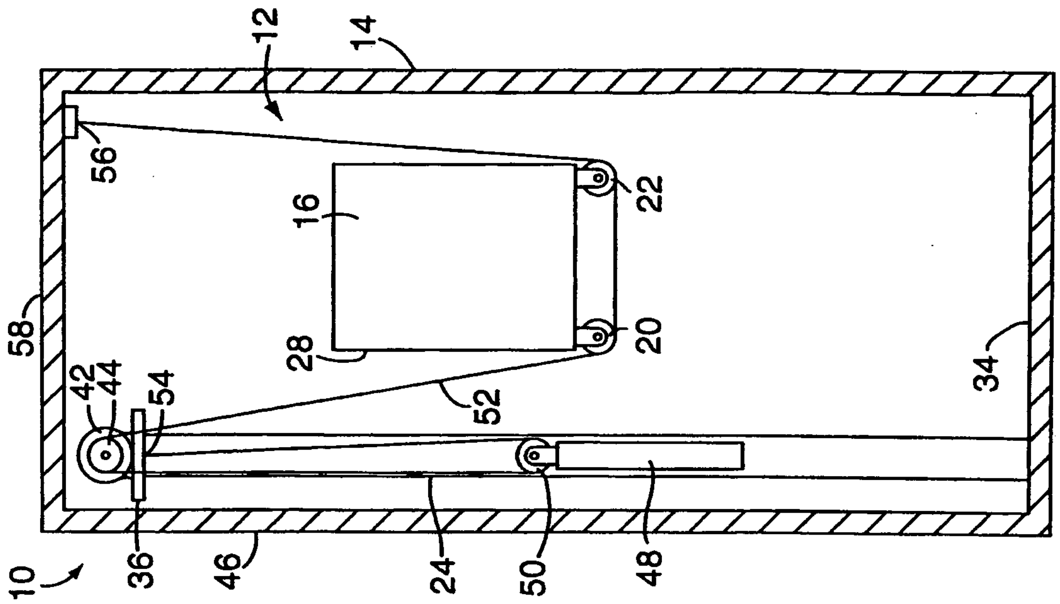
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FIG. 2

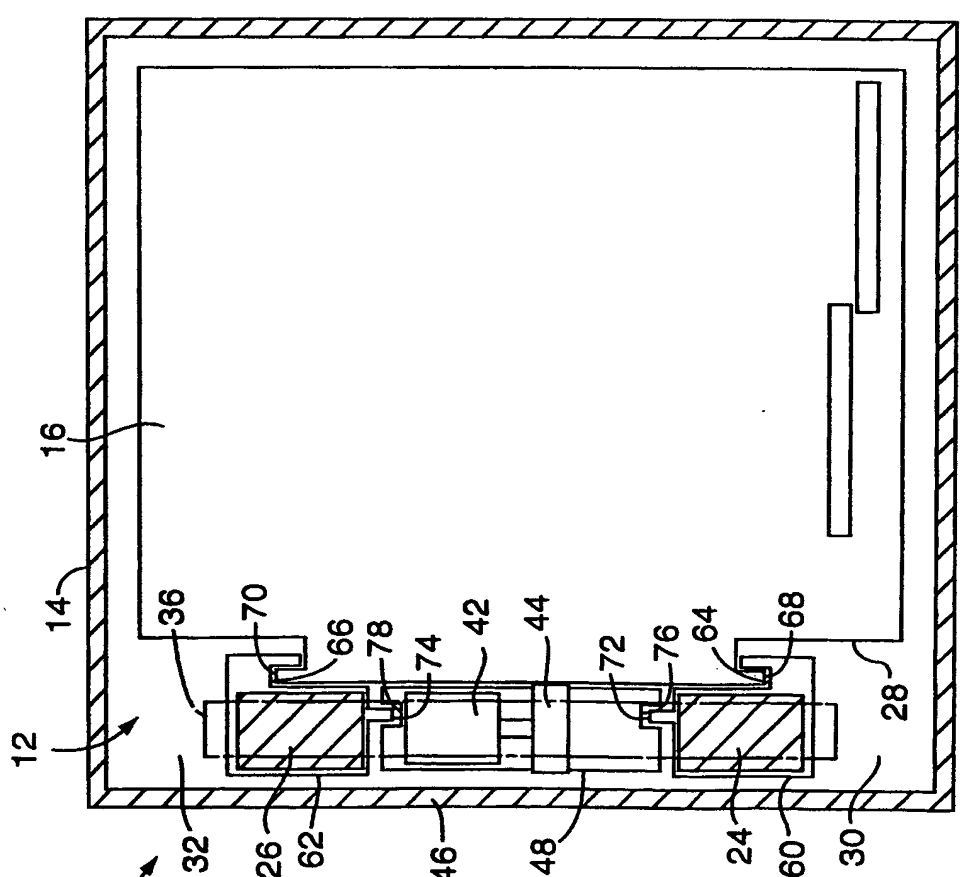
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FIG. 1

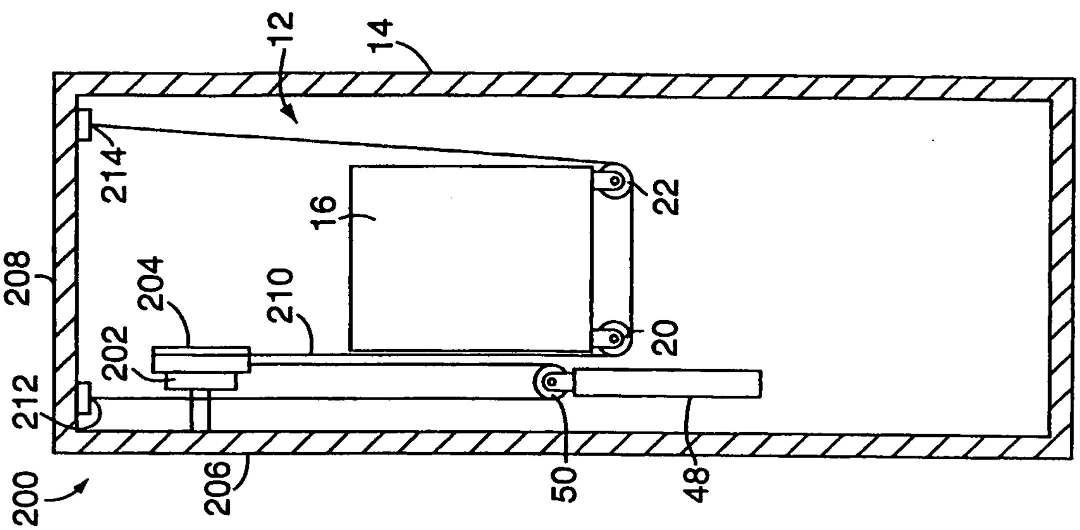
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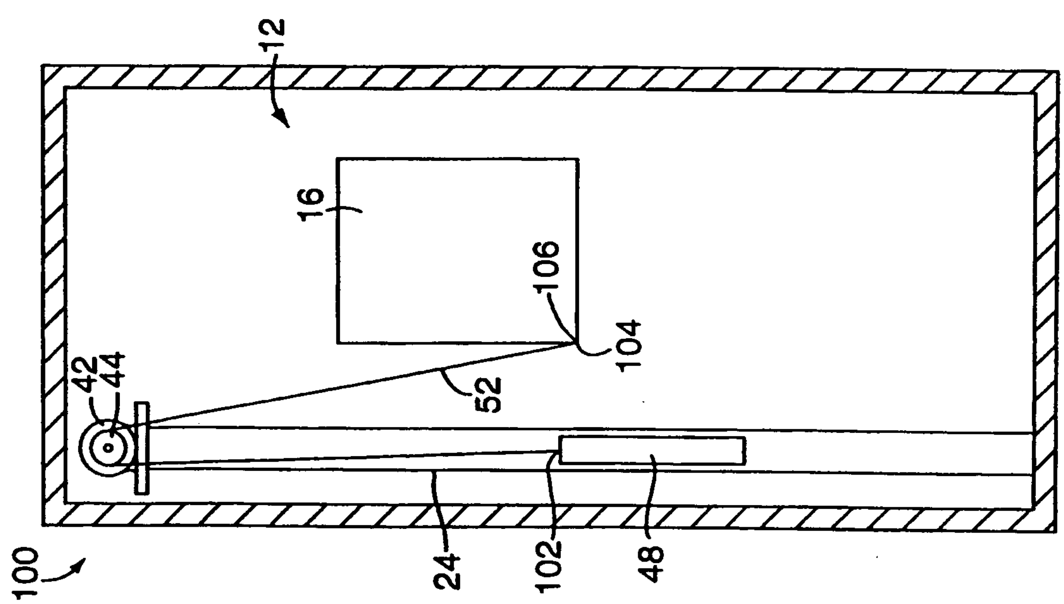
FIG. 4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44
52
100
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102
48

FIG. 3

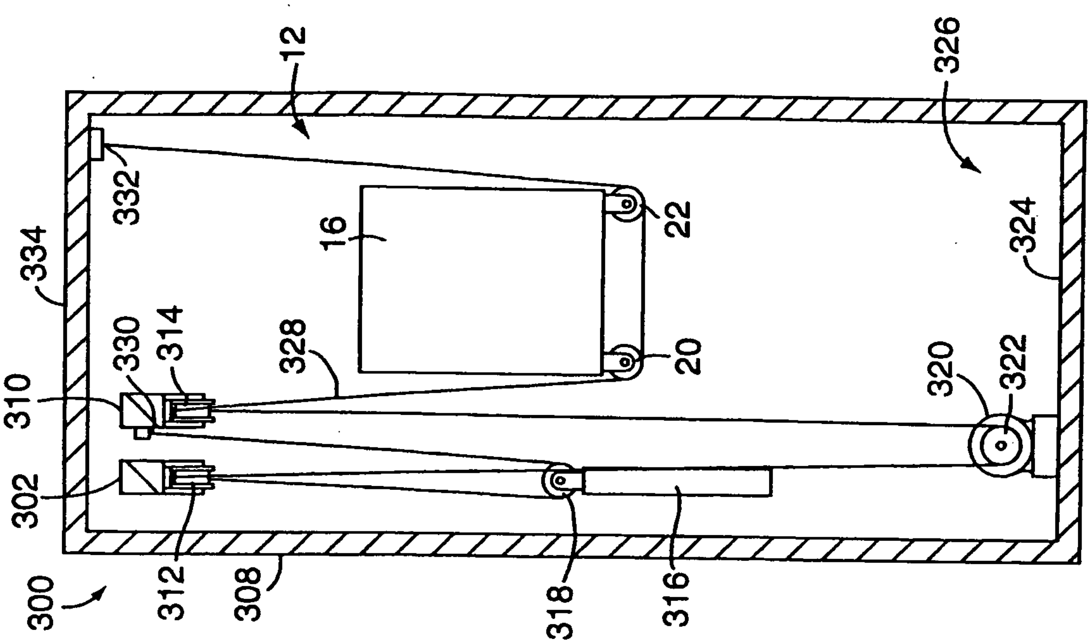
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FIG. 6

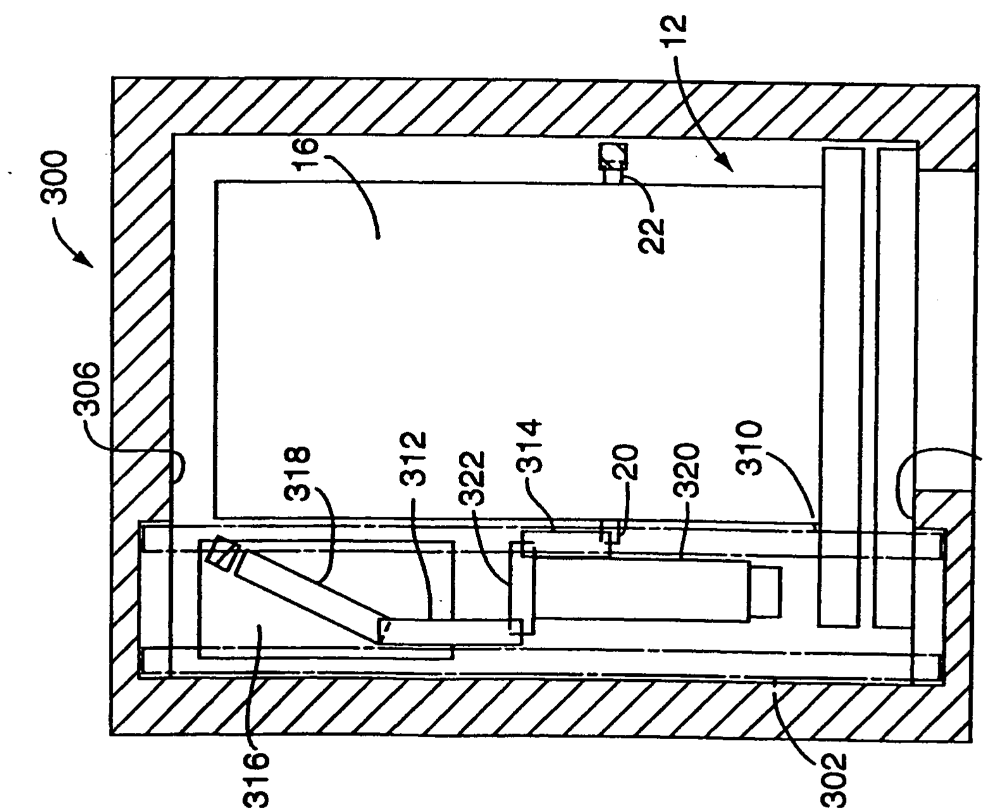
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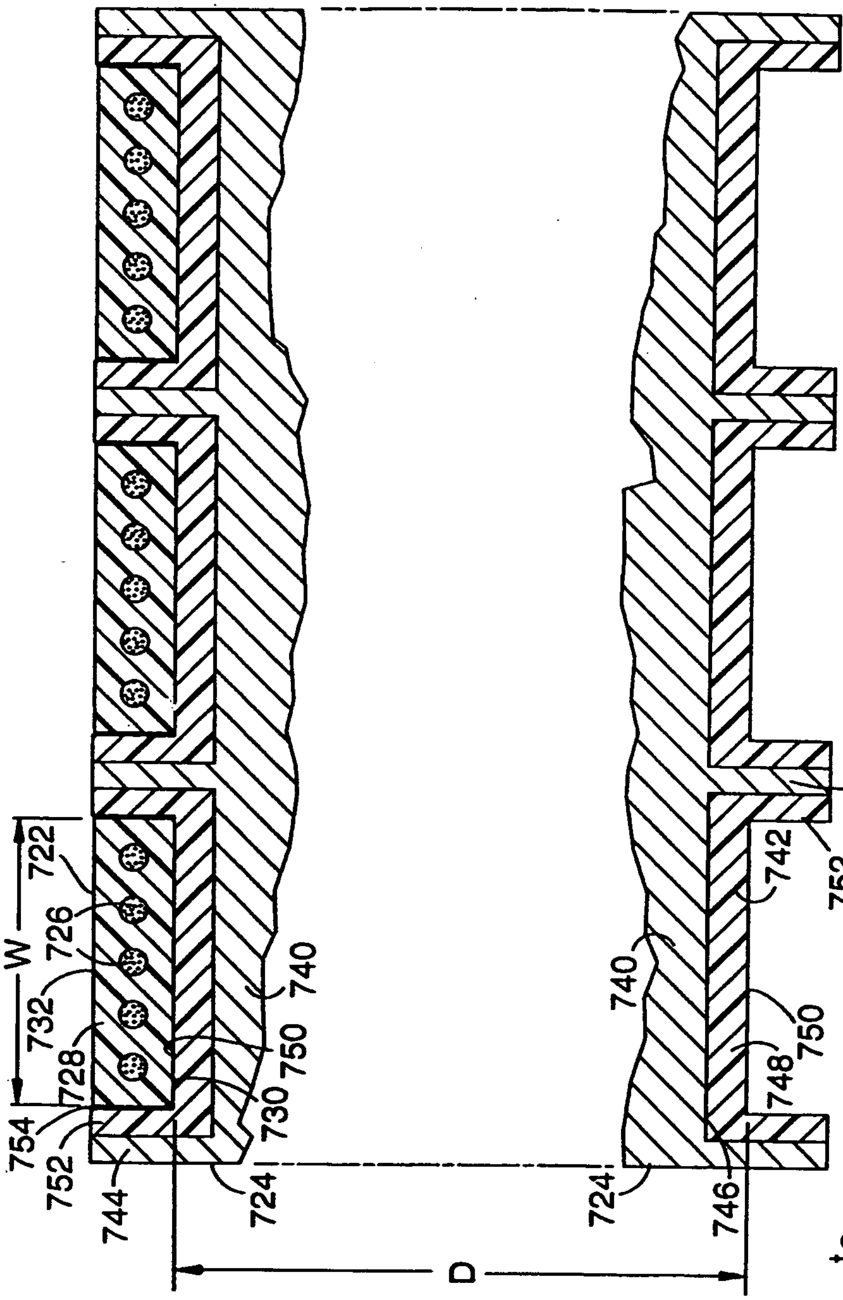
FIG. 5


722
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D
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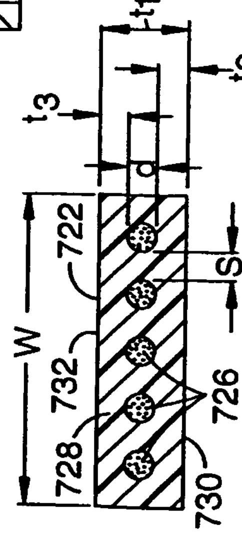
FIG. 7


t_1
t_2
t_3
d
722
S
W
732
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726
730

FIG. 8